MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

EBI4026 – BIOSENSORS

(BE)

18 OCTOBER 2018
2.30 p.m - 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 3 pages with 4 Questions only.
2. Attempt **ALL (4)** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

(a)(i) Draw a diagram with the labels for a general construction of biosensor. [2 marks]

(ii) What is meant by analyte in biosensors? [2 marks]

(iii) Explain the transducer in biosensors. [2 marks]

(iv) Give an example of transducer. [2 marks]

(b)(i)What are the four main types of transducers for biosensors? [4 marks]

(ii) Explain the following electrochemical transducers:
(I) Potentiometric
(II) Voltammetric [2 + 2 marks]

(c)(i) Explain the setup of hydrogen peroxide detection. [2 marks]

(ii) Write the reaction of H_2O_2 oxidation occurs at the platinum surface. [2 marks]

(d) List the five major tasks involved in designing a biosensor once a target analyte has been identified. [5 marks]

Question 2

(a)(i) Write a general oxidation reaction in monoenzymatic system using oxidase. [3 marks]

(ii) Explain the oxidase in oxidation reaction. [2 marks]

(b) List the three methods of immobilization for the selective element connected to transducer in biosensors. [3 marks]

(c)(i) Briefly explain the enzyme used in biosensors. [3 marks]

(ii) What are the advantages of using enzymes in biosensors? [3 marks]

(iii) Why does an enzyme not always totally specific for one reaction? [3 marks]

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Question 2

(d) What are the disadvantages of bifunctional or multifunctional reagents that induce intermolecular cross-linking used to insolubilize enzymes? [3 marks]

(e)(i) Describe an example of immobilized enzyme electrode using glucose oxidase. [2 marks]

(ii) What are the factors affecting the performance of enzyme electrode in enzyme-based biosensor? [3 marks]

Question 3

(a) What are the ways in which conducting polymers can act as ion-selective electrodes? [2 marks]

(b)(i) Explain how a biosensor using ion-sensitive field effect transistor (ISFET) to measure a specific organic substance. [3 marks]

(ii) Explain the reaction involved in a urea ISFET biosensor. [5 marks]

(c)(i) Explain the output performance of ISFET biosensor. [2 marks]

(ii) How does the response time of glucose sensor relate to the membrane thickness? [2 marks]

(d)(i) Why the SOS (silicon on sapphire)/ISFET more suitable for the design of biosensors used for solutions? [3 marks]

(ii) Describe the structure of SOS/ISFET for biosensing technology. [3 marks]

(e) List the five advantages of ISFET over the conventional ion-selective electrode (ISE) biosensor. [5 marks]

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Question 4

(a)(i) Briefly explain a non-mediated fiber-optic biosensor. [3 marks]

(ii) What are the basic requirements for the construction of the non-mediated fiber-optic biosensors? [5 marks]

(b) The chemiluminescent reaction with hydrogen peroxide requires the use of a catalyst and/or cooxidant as below:

$$\text{Luminol} + 2H_2O_2 + OH^- \xrightarrow{\textit{catalyst or cooxidant}} \text{3-amoniphthalate} + N_2 + 3H_2O + h\nu$$

(i) Does this reaction involve the oxidation reaction? Explain your answer. [1 + 2 marks]

(ii) Give an example of catalyst or cooxidant other than the one from part (b)(i). [2 marks]

(c)(i) What is bioluminescence in fiber-optic biosensor? [2 marks]

(ii) Give two sources of bioluminescence. [2 marks]

(d)(i) The bioluminescence reaction of the American firefly *Photinus Pyralis* has been extensively studied by DeLuca and McElroy. In vitro, firefly luciferase catalyzes the production of light in the presence of ATP, Mg^{2+}, molecular oxygen and a specific substrate, luciferin. Explain the light involved in this reaction. [4 marks]

(ii) Write the expression for bioluminescence reaction of the American firefly *Photinus Pyralis*. [4 marks]

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